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A NEW PORTABLE FIELD WATER METER AND A NEW FURROW WATER METER

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Often an accurate record of the volume of irrigation water applied to an area would be a valuable addition to the data on crop production. Such a record is especially useful where the effectiveness of an application is doubtful or where the effect of various irrigation rates or of total applications is being studied. For use in such situations two portable water meters have been designed. They are easily constructed by anyone, and are accurate if made to the specified dimensions.

Portable Field Water Meter

The larger portable field water meter can be made of either wood or sheet metal. The only item that need be purchased, if wood or sheet metal is on hand, is a recorder unit or head with a case for a standard domestic water meter. This assembly sells for about $3.50. The accompanying sketches present details of the wooden meter. When sheet metal is used, one should adhere to the inside dimensions of the various parts of the box in order to reproduce the internal areas given for the wooden design.

Figure 1 shows the meter in place on the side of a ditch, ready to measure the water delivered to the field. In the view from above, the meter is shown held in place to the bulkhead by two bolts with tightening nuts; in the side view it is shown seated on a rubber stop, or any soft-sealing surface on the bottom edge. The tightening of the nuts on the bolts forces the tapered edge of the meter box into the correspondingly tapered seats on the bulkhead, effecting a watertight seal.

Figure 2 gives the assembled meter alone, in greater detail. The dimension b is the thickness of the wood used in construction, presumably about 3/4 inch or the finished thickness of 1 × 12 inch or 1 × 10 inch lumber. When building the meter, one can make rather distinct sections for assembly into the whole.

Figure 3 shows the first two of these sections, namely the bottom (detail I) and the throat (detail II). As can be seen, the bottom assembly will permit the fitting of the throat assembly to it, particularly as far as inside dimensions are concerned. Wood of uniform thickness (b) should be used so that the outside faces of the assembly will match or register. The bottom in detail I has been cut out to show that the bottom boards proper are recessed upward into the outside rectangular framing of the bottom assembly, the distance b. In some dimensions given, b is added; in others, b is subtracted. These plus or minus values are the corrections that the constructor must make in dimensioning the parts to complete the reproduction. The throat in detail II is a true circle cut out of the horizontal bottom boards of the traylike 12 × 10 inch inside compartment. The center of this circular hole is in the exact center of the 12 × 10 inch rectangular area. One may have to tack a couple of light scabs (cleats) below the tray after cutting out the hole, to tie the stub ends of the bottom boards together without obstructing the hole. These scabs are not shown.

Figure 4 contains two more detail drawings of the unit. The upper detail (III), shows the two wing walls with the crosspiece between, which supports the water-meter register. The lower detail (IV) shows the two tapered-edge strips that connect the parts shown in details I, II, and III, along the adjoining surfaces of the inlet face of the assembly. The slotted strap-iron pieces fastened to these edge strips should be 1/8 inch thick, or heavier, and at least 1 inch wide. The slot, 5/16 inch wide, may be cut through half the width of the strap. These slotted strap irons which are on the meter assembly determine the location of bolts on the bulkhead, or bulkheads if the meter is being used at a number of settings. Correspondingly, the tapered-edge seats on the bulkhead must be so located that the vertical seal faces will close before the meter frame butts up against the bulkhead. Obviously, the faces on the tapered seal strips must be plane surfaces on both the bulkhead and the meter.

The moving and recording part of the meter is detailed in figure 5, an assembly drawing that shows all the parts in place. Also shown is the concrete throat which does not appear in detail II. This throat is made smooth by hand-surfacing all the way around the inside of the tray (detail II), between the top inside face of the tray and the metal throat that is located in the circular hole through the floor of the tray.

Figure 5 includes also a 2-inch-wide metal

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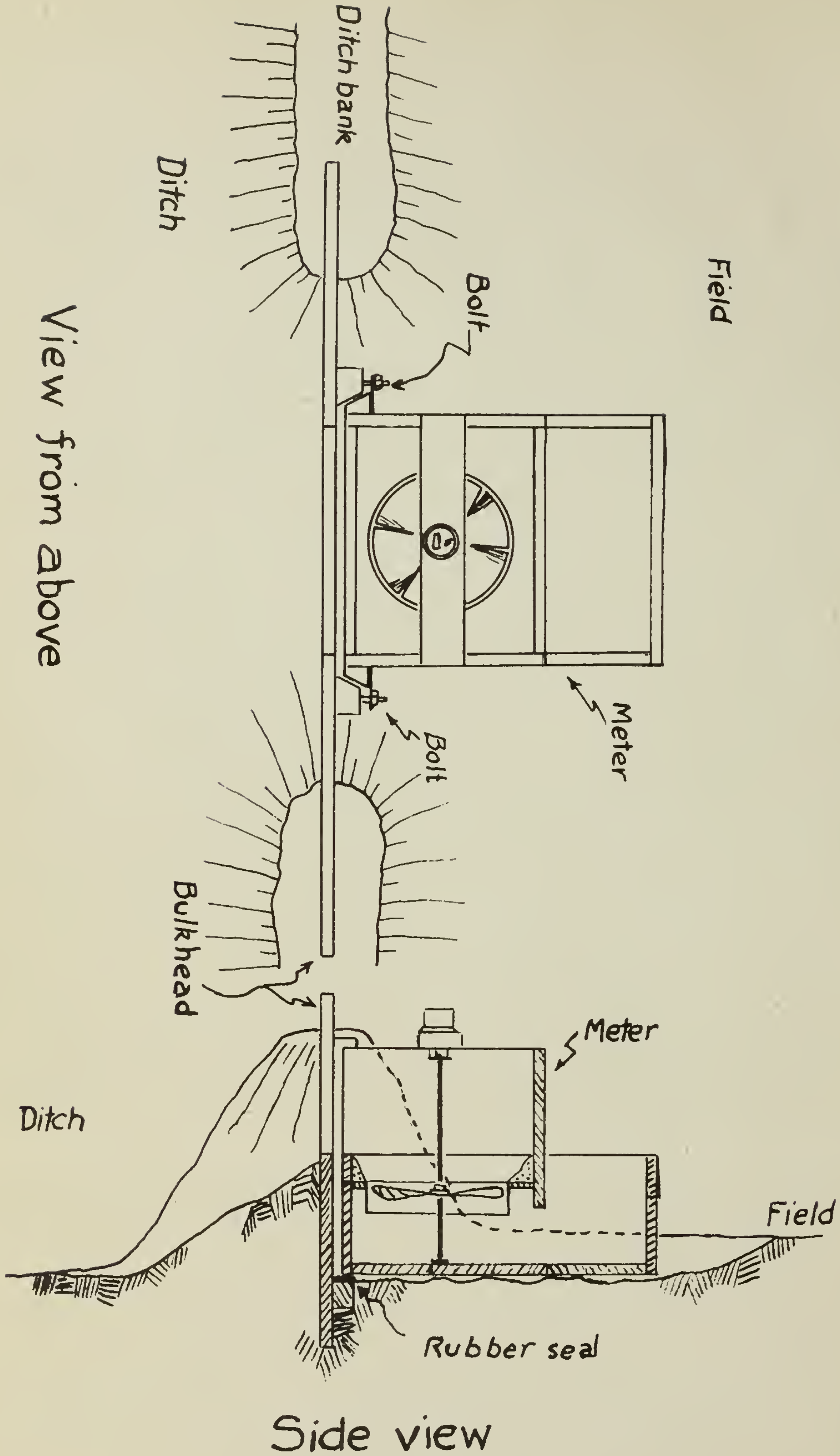

Fig. 1.--Meter ready to measure water delivered to field. The lower view shows a cross section of the ditch bank and meter; the upper shows the installation as viewed from above.

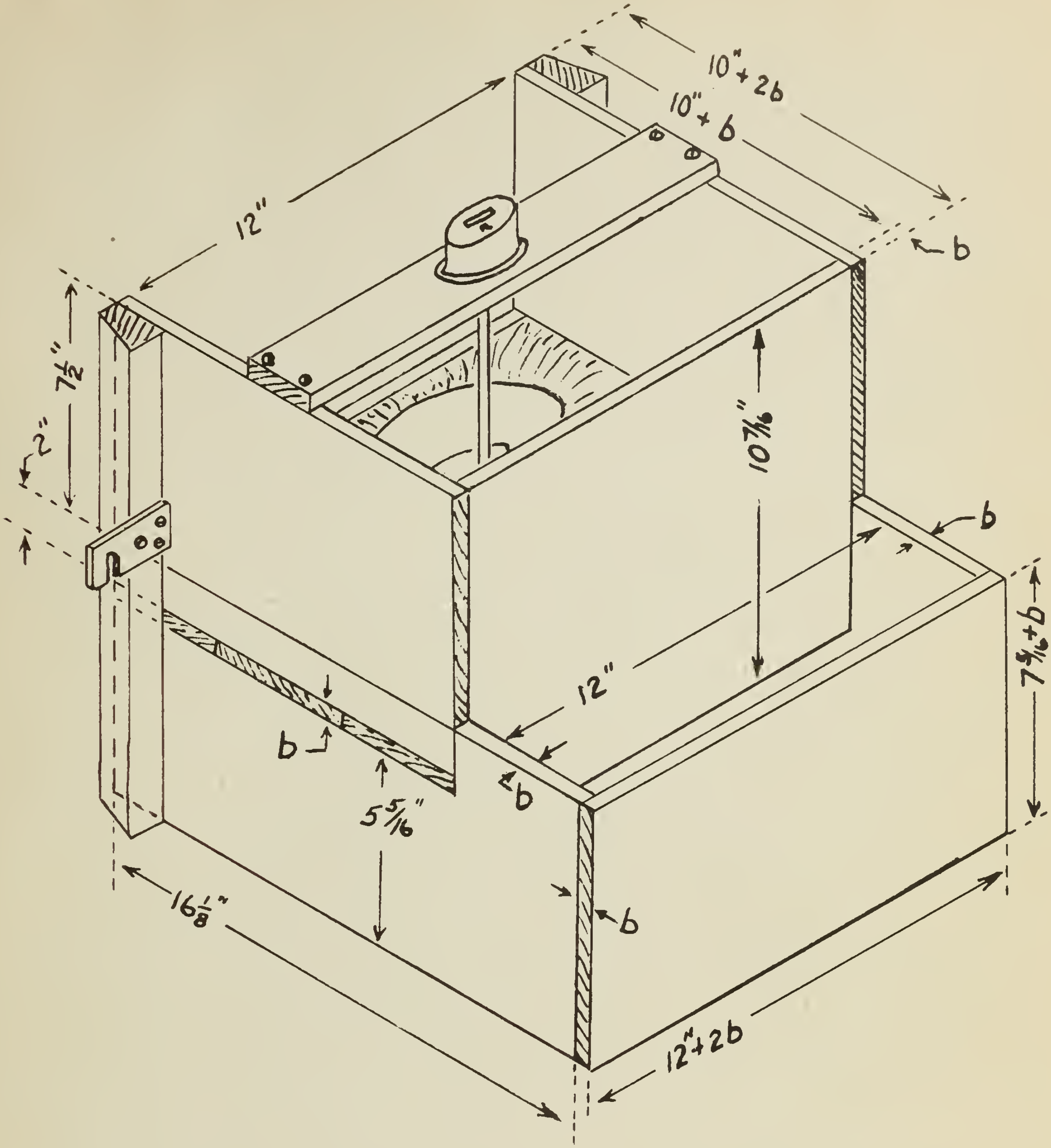

Fig. 2.--The assembled meter shown in detail. Figures 3 and 4 show details of the component parts.

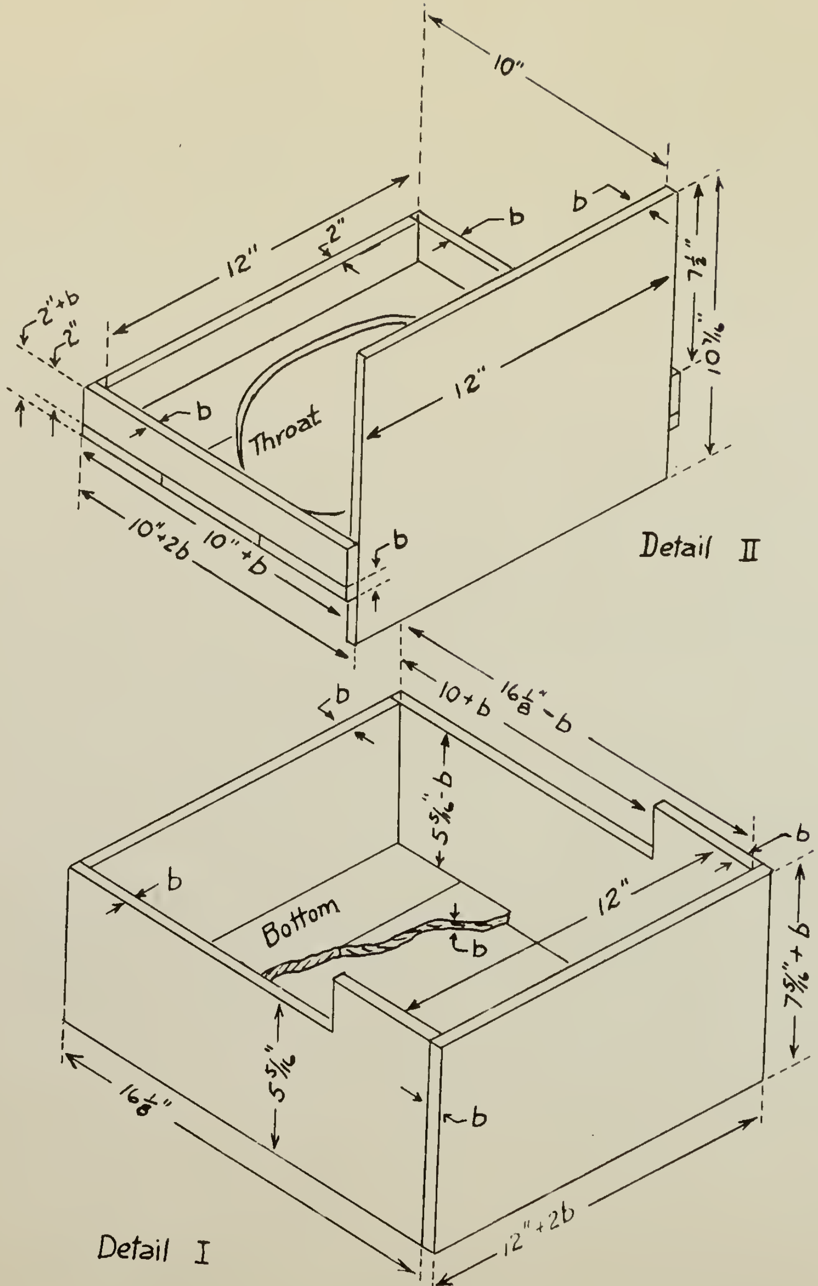

Fig. 3.--Bottom (detail I) and throat (detail II) sections of meter.

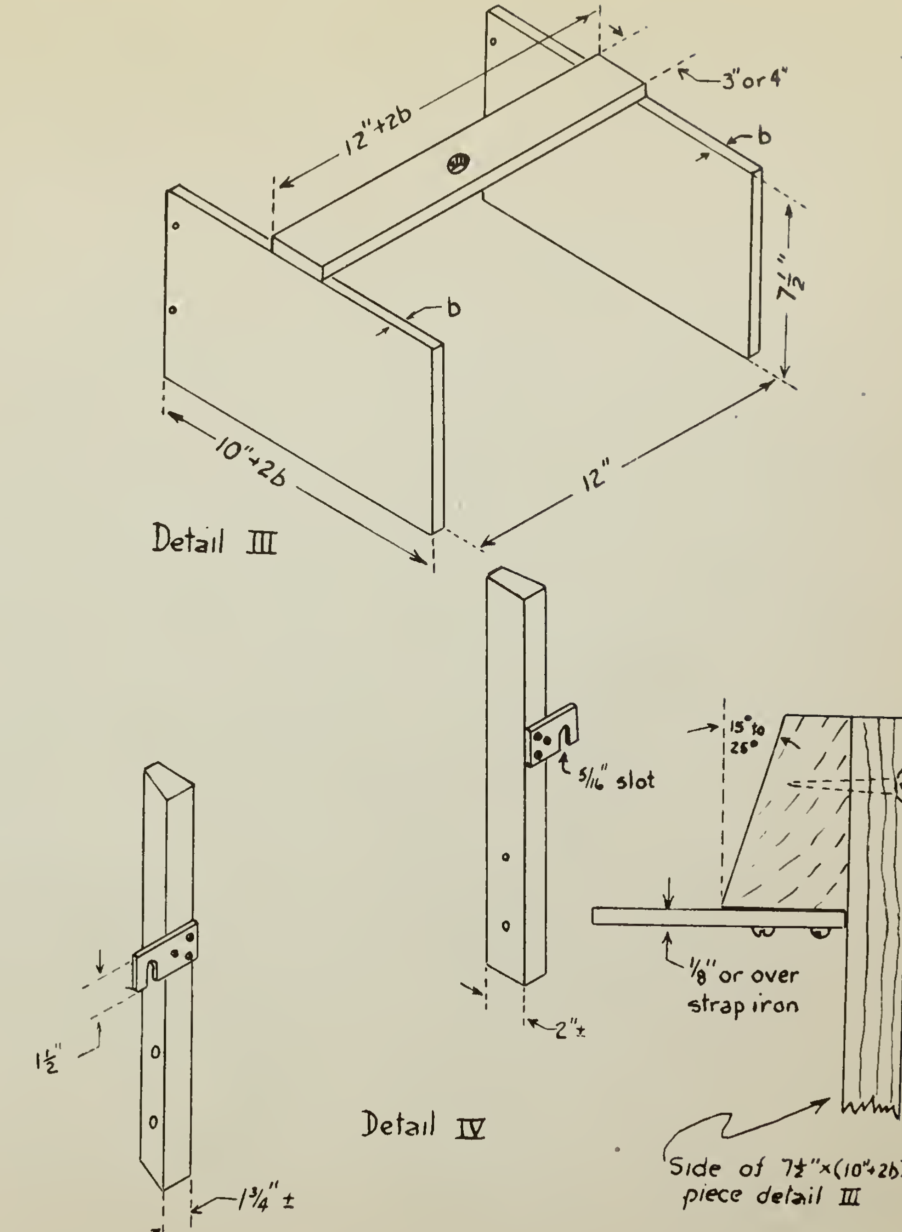

Fig. 4.--Wing walls and crosspiece (detail III) and the tapered-edge strips (detail IV) that form the seal on the edge of the bulkhead.

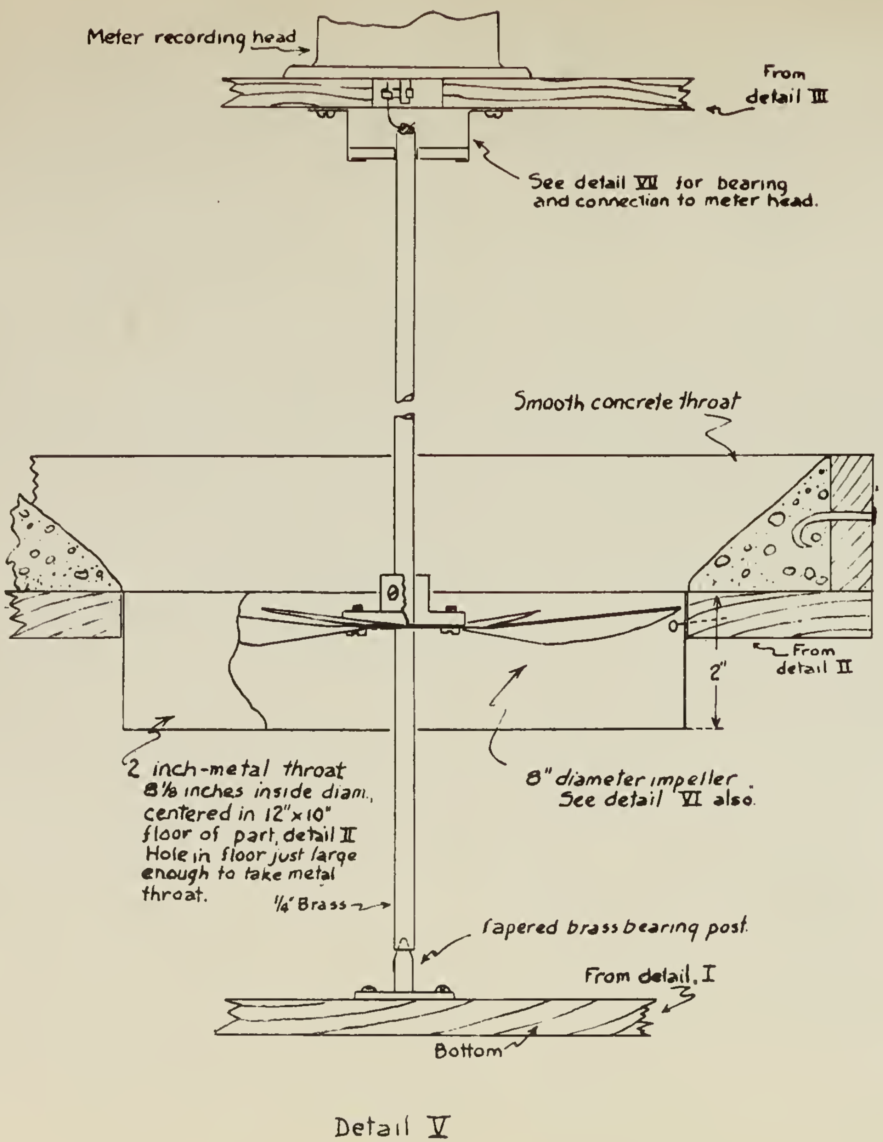

Fig. 5.--Detail of impeller assembly and 2-inch metal throat.

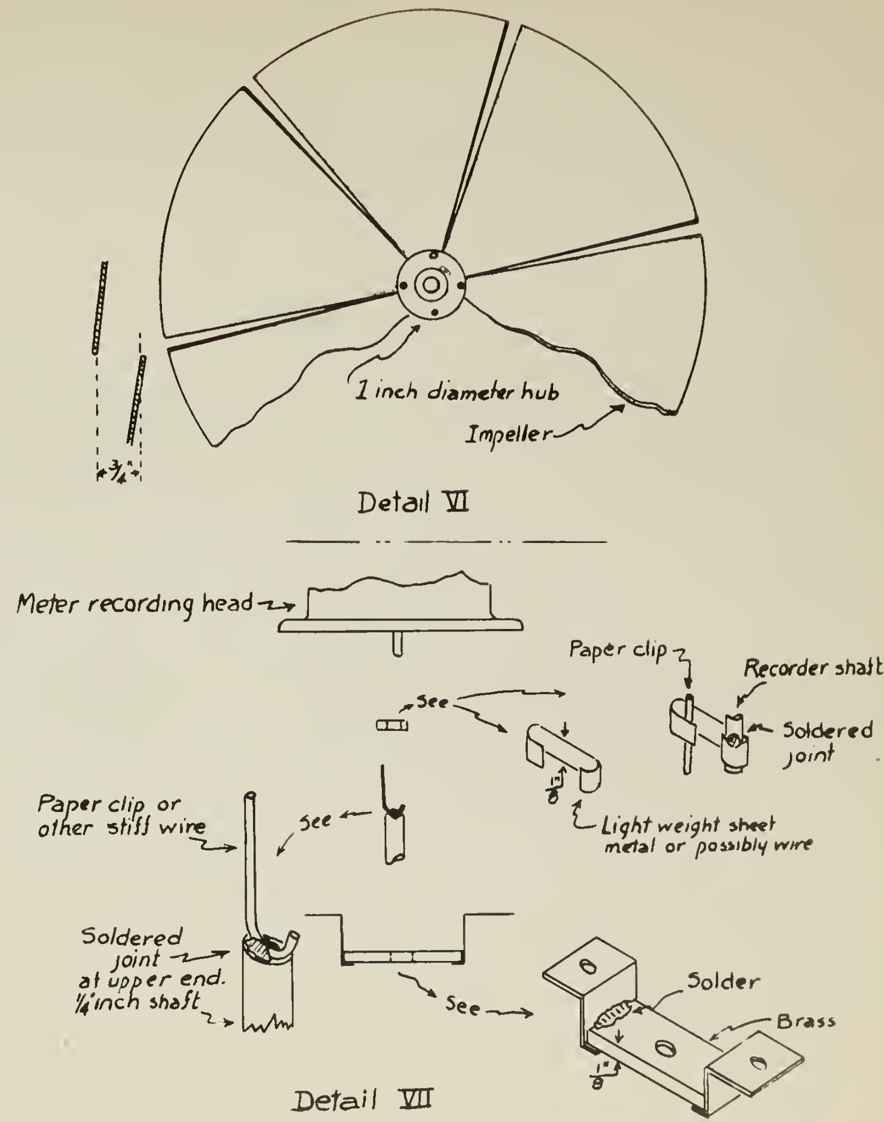

Fig. 6.--Construction of impeller vanes (detail VI) and parts connecting rotating shaft and water-meter recording head (detail VII).

throat that surrounds the impeller with a maximum clearance of 1/8 inch. This metal throat is tacked to the hole cut in the bottom of the tray (detail II), and the hole must be cut to fit exactly the outside of the metal throat. Small nails can be used to join the metal throat to the wooden sides of the hole. The location of the upper and lower bearings is obtained by adjustment when the box is completed. The impeller, centered in the metal throat (fig. 5), must make no contact when turned; and so the shaft will be normal (at 90° angle) to the floor of the bottom section (detail I). The lower bearing on the rotating shaft (fig. 5) is simply a tapered stationary shaft, seating in a small hole that is drilled or countersunk in the center of the rotating shaft. The stationary tapered pedestal is soldered to the base or is turned on a lathe out of larger stock that forms the base. The rotating rod itself should not be smaller than the 1/4-inch diameter specified; otherwise it will be too limber.

The impeller is pictured further in detail VI, figure 6, which shows that its vanes are made by cutting six evenly spaced radial lines from the circumference to within 1/2 inch of the center. Each vane is given a uniform twist so that the distance between the outer edges will be 3/4 inch--a standard dimension which must be kept. The hub that supports the impeller has a set screw in it for pinning the impeller to the shaft. This hub may be eliminated by soldering the impeller to the shaft in a true position so that the top edges of the impeller blades will not sweep higher than 1/8 to 1/4 inch below the top of the metal-throat line.

Detail VII at the bottom of figure 6 pictures the parts that make up the connection between the rotating shaft and the water-meter recorder head, as well as the bearing below that head.

The bearing is kept thin (not over 1/8 inch) to reduce friction and is centered by trial when the meter assembly is completed. Details of its construction are immaterial, and the unit illustrated is a simple one to follow. The paper clip or stiff wire at the top of the revolving shaft drives the recorder shaft through a flexible coupling: on the countershaft is soldered a light, narrow metal strip or wire; either one will be bent to retain loosely the end of the paper clip, as shown at the right. Any other flexible coupling that might be devised with no friction-consuming characteristics would be equally satisfactory.

A meter made to these specifications should be calibrated against some reliable water-metering device before being put to use. If, however, one lacks the facilities for a calibration run, one can put the unit into operation, assuming that each revolution of the meter equals about 0.07 cubic foot delivered. On this basis, assuming that 3 inches of water are to be applied to a field just 1 acre in area, the meter would have to make a computable number of turns. The computation follows:

Area, 1 acre = 43,560 square feet.

Depth of water to be applied, 3 inches = 1/4 foot.

Volume of water to be applied, $43{,}560 \times 1/4 =$ 10,890 cubic feet.

Cubic feet delivered by meter per revolution = 0.07 cubic foot.

Revolutions of meter to irrigate 1 acre 3 inches deep $= \frac{10{,}890}{0.07} = 155{,}571$.

The meter will record an increase of 155,571 revolutions before the field comprising 1 acre will have received a 3-inch application of water. A quick check of the meter at the start of the run enables the operator to record the initial reading on the dial and, by timing the counter for 1 minute, the revolutions per minute. Suppose the meter were being turned at 121 revolutions per minute. Then $\frac{155{,}571}{121} = 1{,}285.7$ minutes would be required to put on the desired volume of water, or $\frac{1{,}285.7}{60} = 21.43$ hours. Obviously, the meter is useful for small flows only when so long a period is required to put 3 inches of water on an acre. It can handle about 120 gallons per minute maximum or about 1/4 cubic foot per second. For this reason it is useful only for test work on small fractions of an acre, but is ideal for experimental plots which are often laid out in 1/10-acre units.

Several bulkheads can be prepared to receive the meter which can be moved from one to the other as desired. To seal the opening in the bulkheads, one may insert into the opening a board with cleats fastened on the inside to hold it (see figure 7); this device seals the inside face of the bulkhead as well. A plug, made to fit into the space occupied by the meter, can be held in place with the tightening nuts and bolts already on each bulkhead (fig. 7).

Furrow Water Meter

For some work, the 8-inch-throat meter just described may be too large--for example, if furrows are being irrigated with very small streams of water. Figure 8 shows a modification of the 8-inch portable meter previously described. The impeller here is 4 inches in diameter, and the housing is made from two tin cans or the equivalent. The cans are joined at the bottom inch or inch and a half by a seal soldered along the edges of the adjoining opened sides. On this 4-inch model, the direction of flow is the reverse of that for the 8-inch model, and the rotor actuates the recorder shaft through a star wheel rather than directly. The star wheel supplies a gear reduction between the rotor shaft and the recorder; the effect is to lessen the drag on the rotor shaft. By keeping the effect of friction down, one can use the small torque of the 4-inch rotor with small flow most effectively. Since this meter closely resembles in construction the 8-inch one described

in detail, no further description will be undertaken. Close-running fits between the impeller and the housing throat are desirable. The operating range lies between 2 or 3 gallons per minute up to 20 or 30. The unit passes about 0.25 gallon (0.0335 cubic foot) per revolution of the recorder when a 6-arm star wheel is used and when there is a 3/16-inch pitch or separation to the impeller blades at the outer circumference. One can calibrate the unit by using a garden hose and weighing the throughput on any scales available. Each gallon of water weighs 8.33 pounds at normal temperatures. From the weight, therefore, the number of gallons can be found; and if the time taken to accumulate that weight of water is known, the gallons per minute can be calculated simply, and also the revolutions of the counter per minute. The gallons per revolution equal the $\frac{\text{g.p.m.}}{\text{r.p.m.}}$ for any given flow and are almost a constant through the operational range above approximately 3 gallons per minute. Below that minimum flow, friction consumes much of the limited torque available. To assure the steady performance of such a small meter, trash and grit should be screened out of the intake.

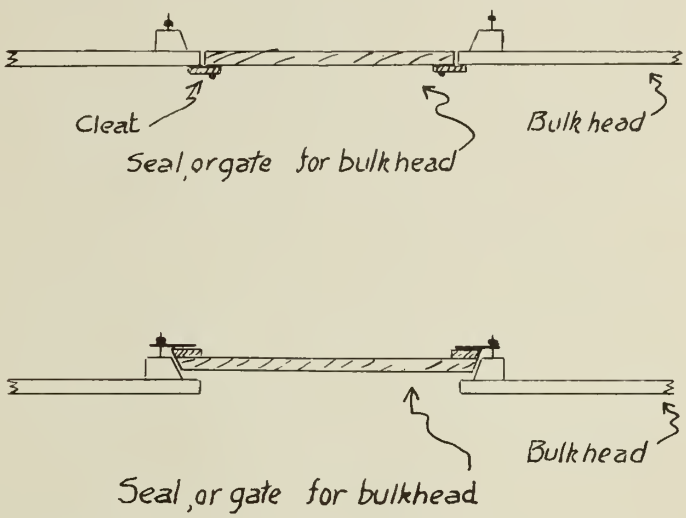

Fig. 7.--Two methods of sealing the opening of bulkheads.

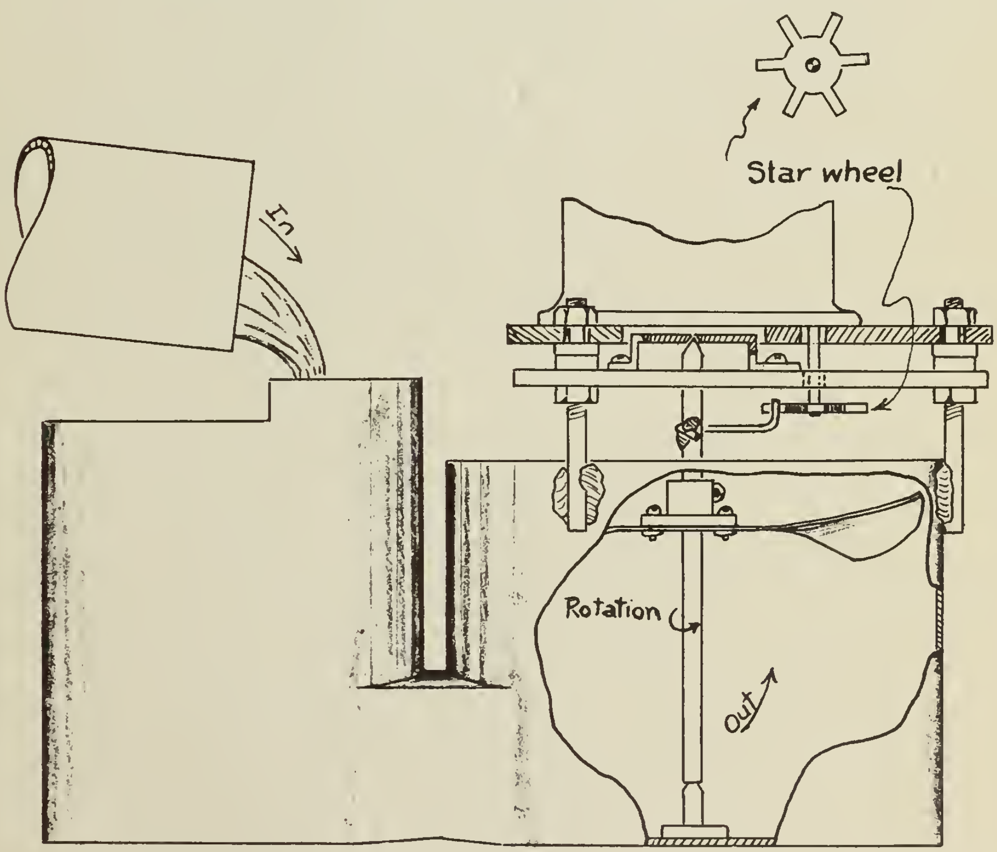

Fig. 8.--Modified 8-inch portable meter used for measurement of water in furrows.